AN2795
Application note

VNI4140K load test report

Introduction

The tests described in this application note were carried out to check the VNI4140K parameters and driving capabilities of different types of problematic loads such as bulb and inductor.

The VNI4140K device is a quad high-side smart power state relay intended for driving four independent resistive or inductive loads with built-in current limitation and thermal shutdown.

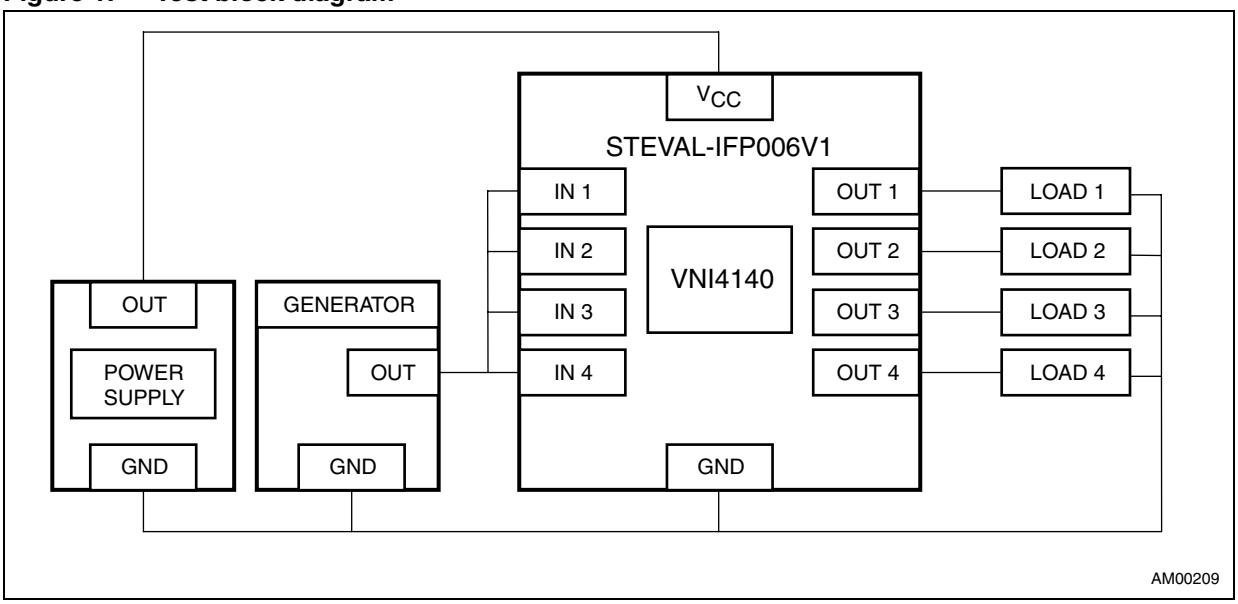
Figure 1 shows the test configuration. The STEVAL-IFP006V1, based on the VNI4140K, was chosen for the measurements. The parameters of the test were set as follows:

Power supply: 1. 10.5 V; 2. 24 V; 3. 36 V

Generator: freq. = 1 Hz, duty cycle = 50%

Load: 1. bulb 24 V/15 W; 2. inductor 130 mH/48 Ω; 3. short-circuit.

Figure 1. Test block diagram



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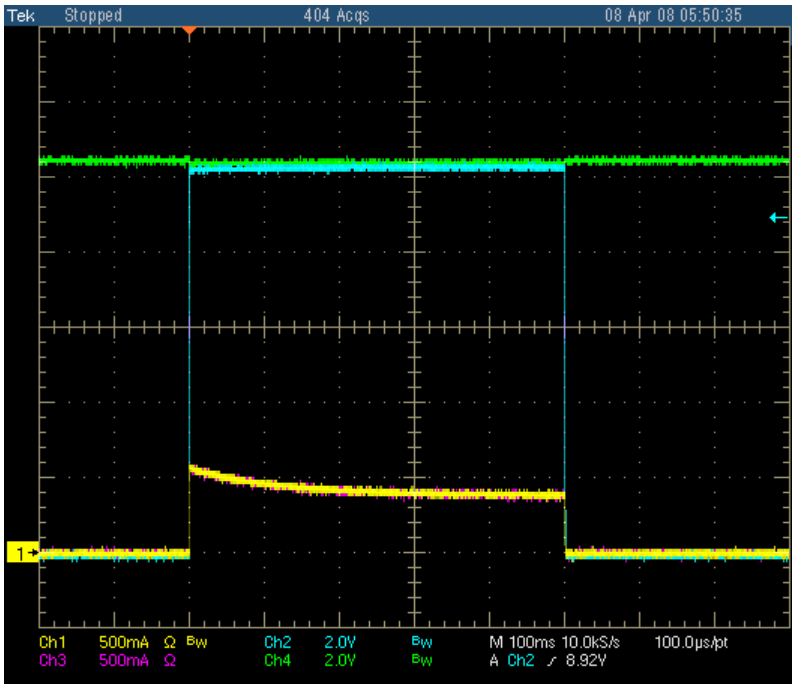
1 Bulb load tests

1.1 Bulb, 10.5 V, 1 channel

Table 1. Test data (bulb, 10.5 V, 1 channel)
(V_{CC} = 10.5 V; load - 1 bulb; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	10.4	0.381	10.3	0.376	25.1
15	10.4	0.383	10.3	0.377	25.6
30	10.4	0.382	10.4	0.376	26.0
60	10.4	0.382	10.4	0.377	26.1

Figure 2. Switching waveform (bulb, 10.5 V, 1 channel)(1)



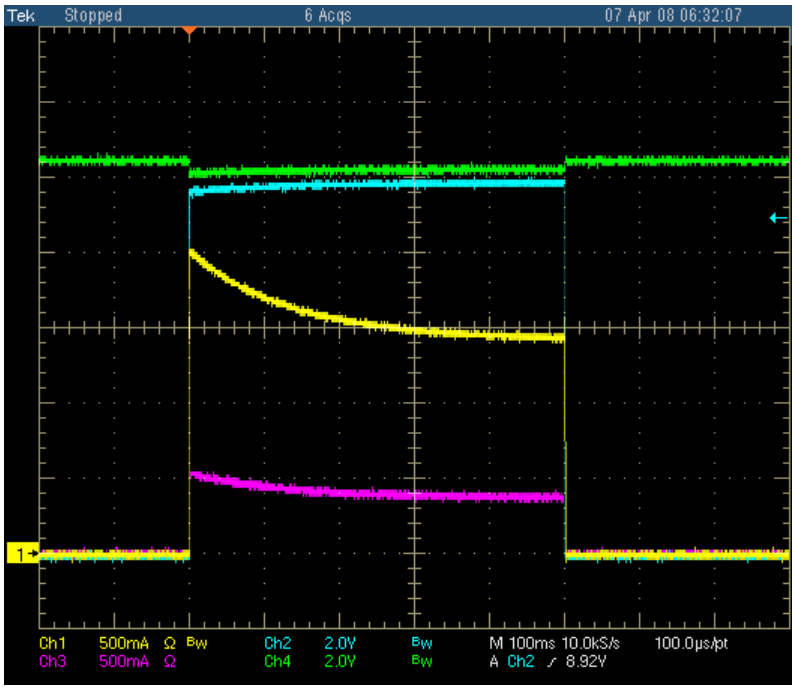
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

1.2 Bulb, 10.5 V, 4 channels

Table 2. Test data (bulb, 10.5 V, 4 channels)
(V_{CC} = 10.5 V; load - 4 bulbs; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	10.3	1.405	9.9	0.365	25.9
15	10.3	1.408	10.0	0.365	26.6
30	10.3	1.409	10.0	0.366	27.0
60	10.3	1.408	10.0	0.366	27.2

Figure 3. Switching waveform (bulb, 10.5 V, 4 channels)(1)



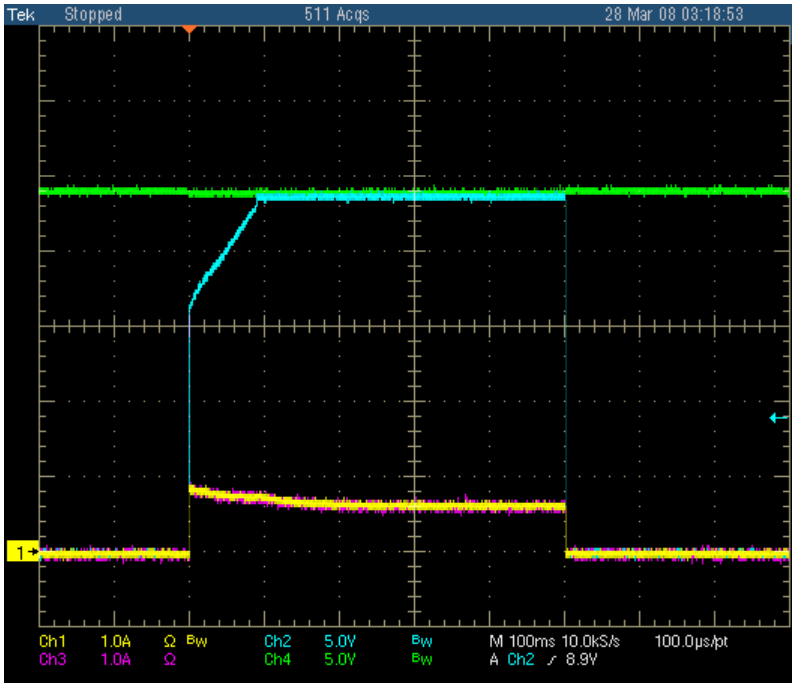
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

1.3 Bulb, 24 V, 1 channel

Table 3. Test data (bulb, 24 V, 1 channel) (V_{CC} = 24 V; load - 1 bulb; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	23.9	0.629	23.8	0.617	36.6
15	23.9	0.629	23.8	0.617	38.4
30	23.9	0.628	23.7	0.616	38.8
60	23.9	0.628	23.7	0.616	38.8

Figure 4. Switching waveform (bulb, 24 V, 1 channel)(1)



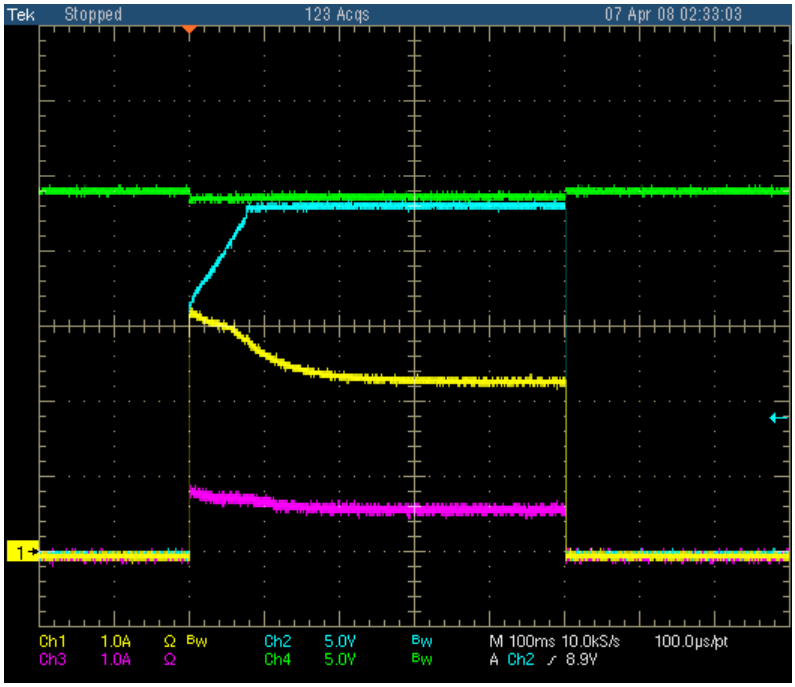
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

1.4 Bulb, 24 V, 4 channels

Table 4. Test data (bulb, 24 V, 4 channels) (V_{CC} = 24 V; load - 4 bulbs; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	23.6	2.301	23.2	0.600	46.5
15	23.6	2.306	23.2	0.599	48.8
30	23.6	2.307	23.2	0.599	50.8
60	23.6	2.306	23.2	0.599	51.1

Figure 5. Switching waveform (bulb, 24 V, 4 channels)(1)



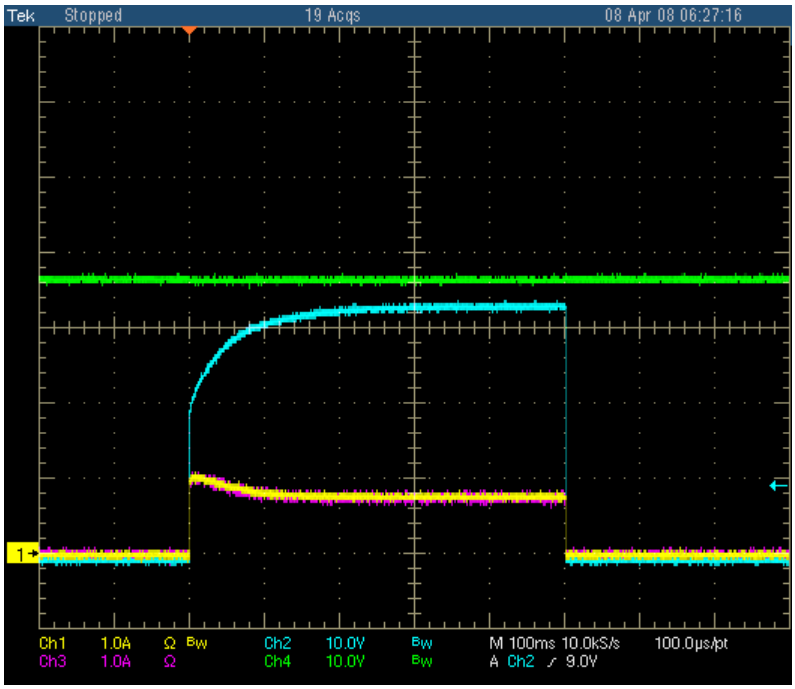
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

1.5 Bulb, 36 V, 1 channel

Table 5. Test data (bulb, 36 V, 1 channel)
(V_{CC} = 36 V; load - 1 bulb; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	35.8	0.767	33.8	0.751	74.9
15	35.9	0.769	33.8	0.752	79.1
30	35.9	0.769	33.8	0.753	80.8
60	35.9	0.769	33.9	0.753	80.8

Figure 6. Switching waveform (bulb, 36 V, 1 channel)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

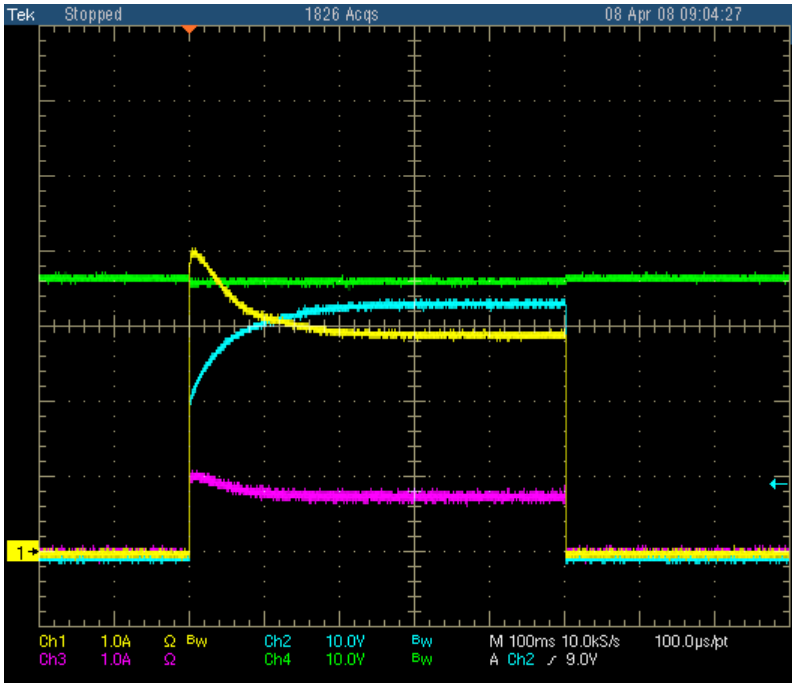
1.6 Bulb, 36 V, 4 channels

Table 6. Test data (bulb, 36 V, 4 channels) (V_{CC} = 36 V; load - 4 bulbs; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	35.5	2.891	34.2	0.748	105.6
15	35.5	2.891	34.2	0.748	110.2
30					(1)
60					(1)

1. Thermal shutdown activated (thermal cycling).

Figure 7. Switching waveform (bulb, 36 V, 4 channels)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

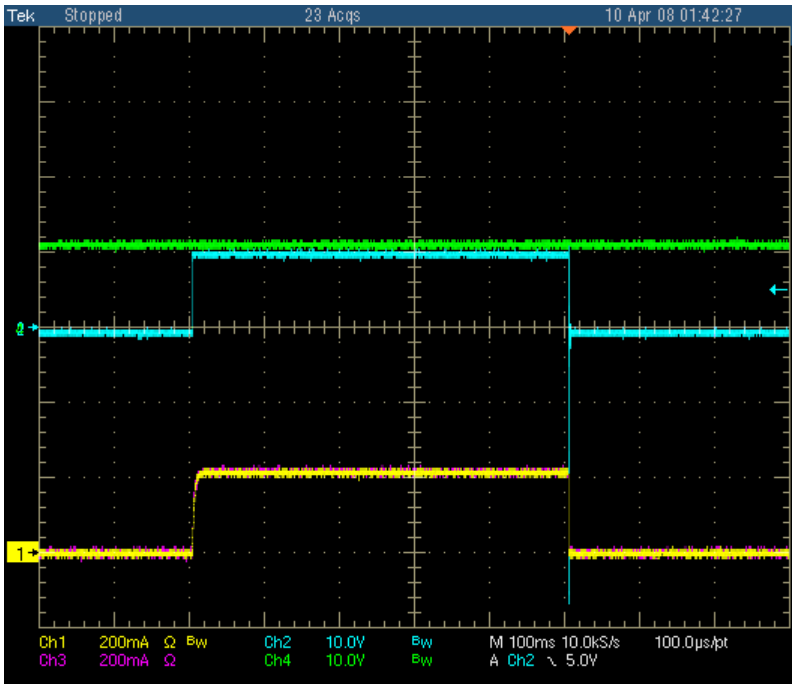
2 Inductive load tests

2.1 Inductor, 10.5 V, 1 channel

Table 7. Test data (inductor, 10.5 V, 1 channel)
(V_{CC} = 10.5 V; load - 1 inductor; T = 25 °C)

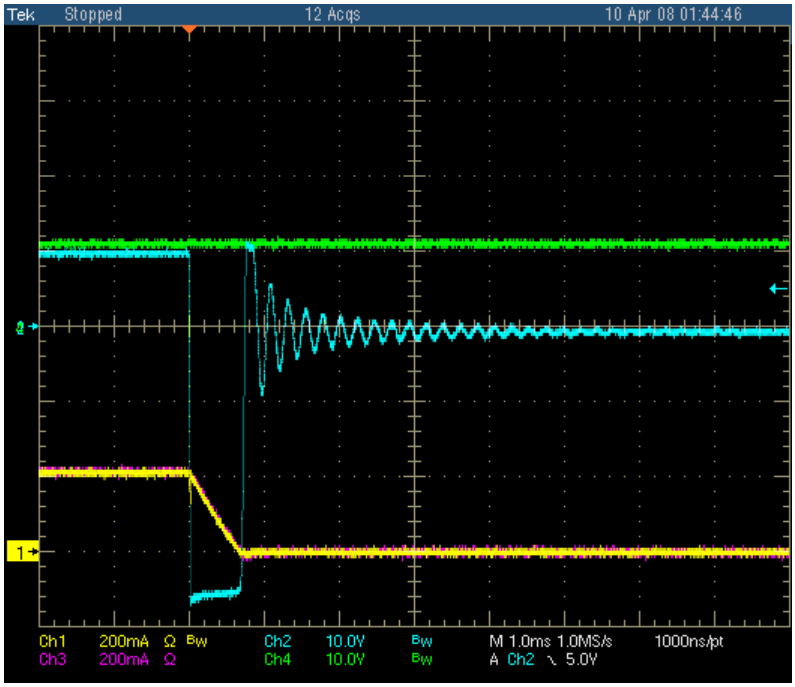
Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	10.5	0.211	10.4	0.209	24.9
15	10.5	0.210	10.4	0.208	25.1
30	10.5	0.210	10.4	0.208	25.2
60	10.5	0.210	10.4	0.208	25.3

Figure 8. Switching waveform (inductor, 10.5 V, 1 channel)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

Figure 9. Switching waveform (inductor, 10.5 V, 1 channel, turn-off detail)(1)



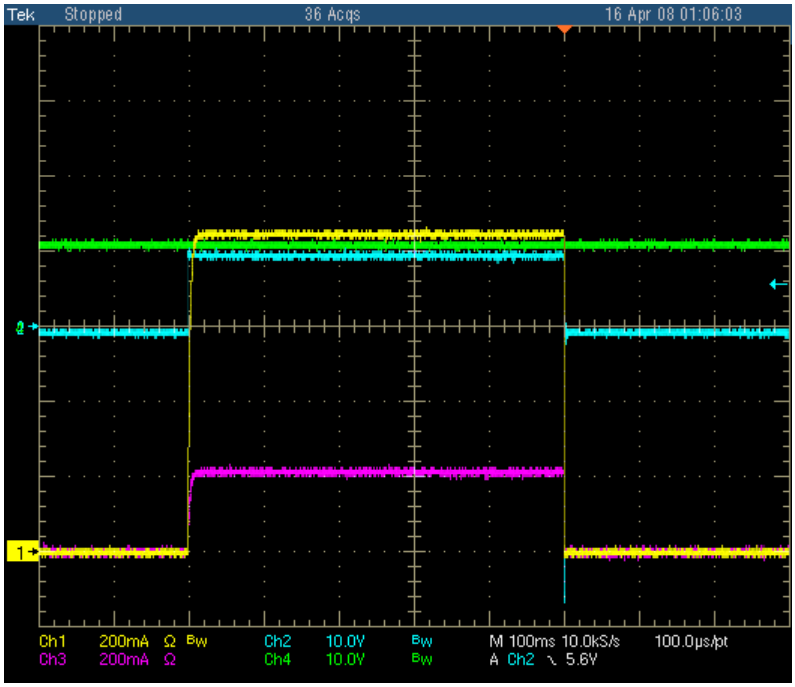
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

2.2 Inductor, 10.5 V, 4 channels

Table 8. Test data (inductor, 10.5 V, 4 channels)
(V_{CC} = 10.5 V; load - 4 inductors; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	10.4	0.822	10.2	0.204	25.6
15	10.4	0.820	10.2	0.204	26.0
30	10.4	0.819	10.2	0.203	26.3
60	10.4	0.819	10.2	0.204	26.7

Figure 10. Switching waveform (inductor, 10.5 V, 4 channels)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

Figure 11. Switching waveform (inductor, 10.5 V, 4 channels, turn-off detail)(1)

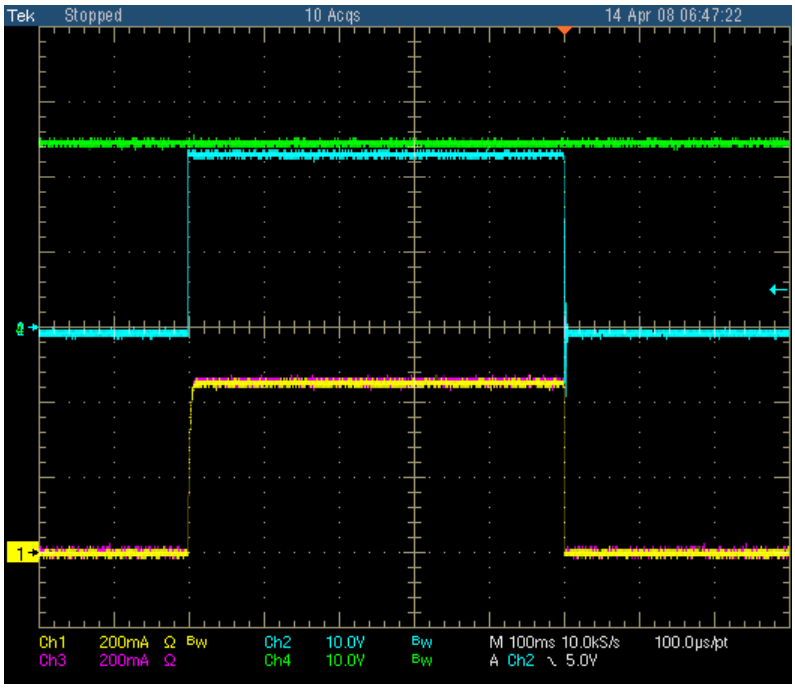
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

2.3 Inductor, 24 V, 1 channel

Table 9. Test data (inductor, 24 V, 1 channel) (V_{CC} = 24 V; load - 1 inductor; T = 25 °C)

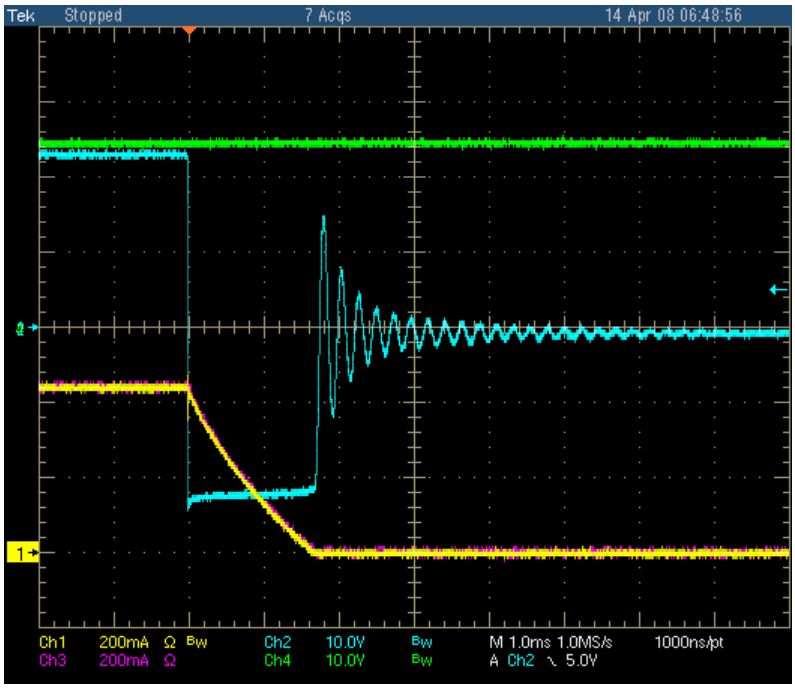
Time [min]	U_{tot} [V]	I_{tot} A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	23.9	0.422	23.8	0.420	25.8
15	23.9	0.429	23.8	0.426	26.2
30	23.9	0.430	23.8	0.427	26.5
60	23.9	0.430	23.8	0.427	26.7

Figure 12. Switching waveform (inductor, 24 V, 1 channel)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

Figure 13. Switching waveform (inductor, 24 V, 1 channel, turn-off detail)(1)



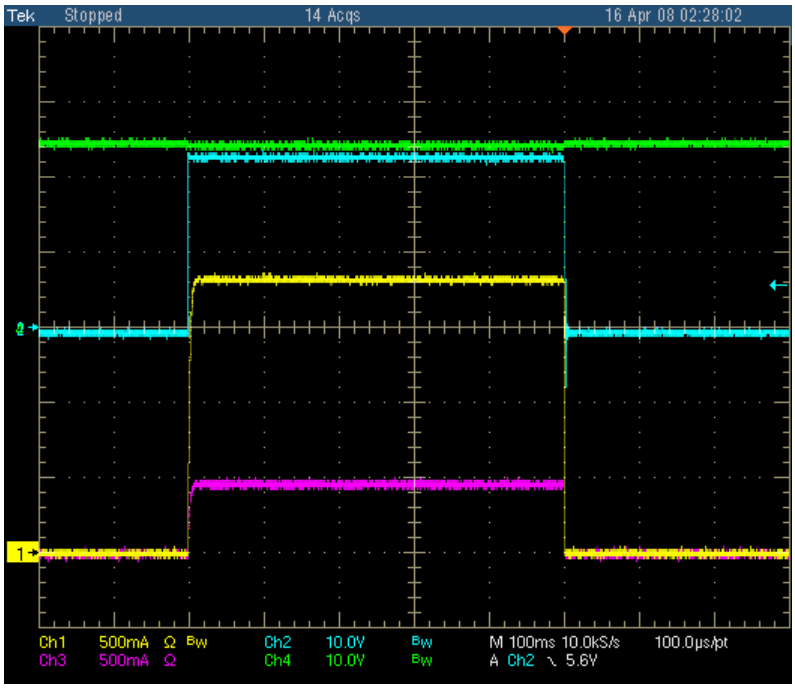
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

2.4 Inductor, 24 V, 4 channels

Table 10. Test data (inductor, 24 V, 4 channels)
(V_{CC} = 24 V; load - 4 inductors; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	23.8	1.690	23.5	0.423	30.6
15	23.8	1.655	23.5	0.418	31.9
30	23.8	1.659	23.5	0.420	32.3
60	23.8	1.658	23.5	0.420	32.5

Figure 14. Switching waveform (inductor, 24 V, 4 channels)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

Figure 15. Switching waveform (inductor, 24 V, 4 channels, turn-off detail)(1)

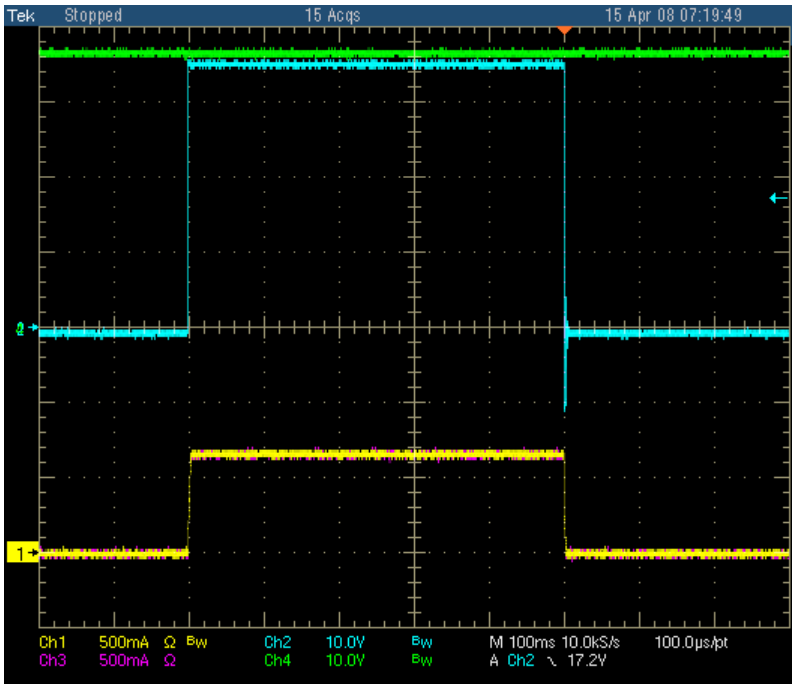
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

2.5 Inductor, 36 V, 1 channel

Table 11. Test data (inductor, 36 V, 1 channel)
(V_{CC} = 36 V; load - 1 inductor; T = 25 °C)

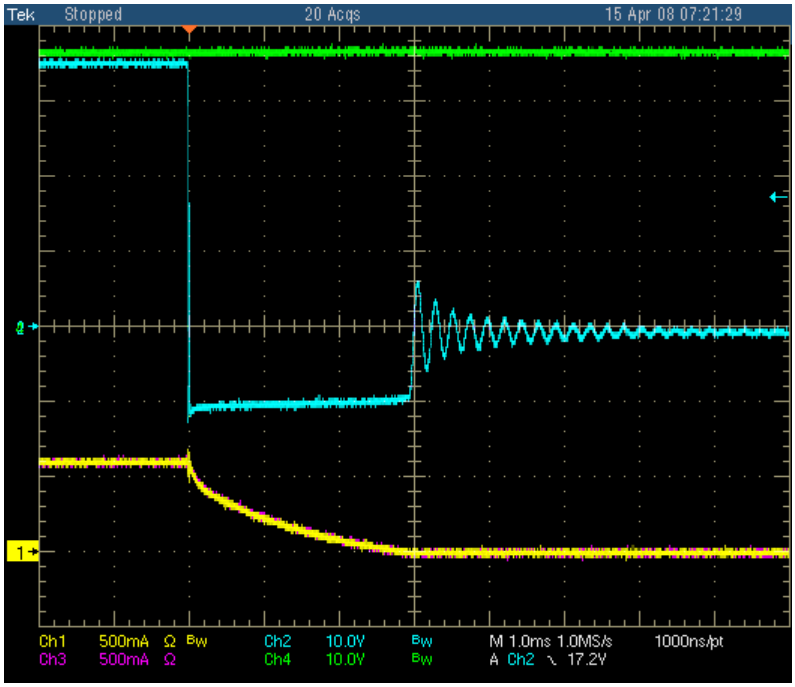
Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	35.9	0.578	35.8	0.572	28.0
15	35.9	0.572	35.8	0.565	28.5
30	35.9	0.572	35.8	0.566	28.7
60	35.9	0.573	35.8	0.568	28.8

Figure 16. Switching waveform (inductor, 36 V, 1 channel)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

Figure 17. Switching waveform (inductor, 36 V, 1 channel, turn-off detail)(1)



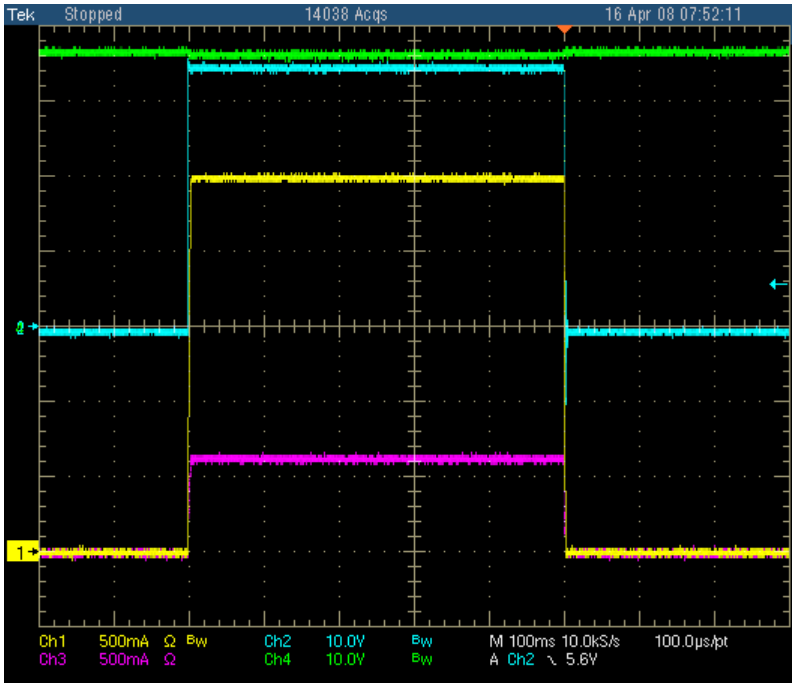
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

2.6 Inductor, 36 V, 4 channels

Table 12. Test data (inductor, 36 V, 4 channels) (V_{CC} = 36 V; load - 4 inductors; T = 25 °C)

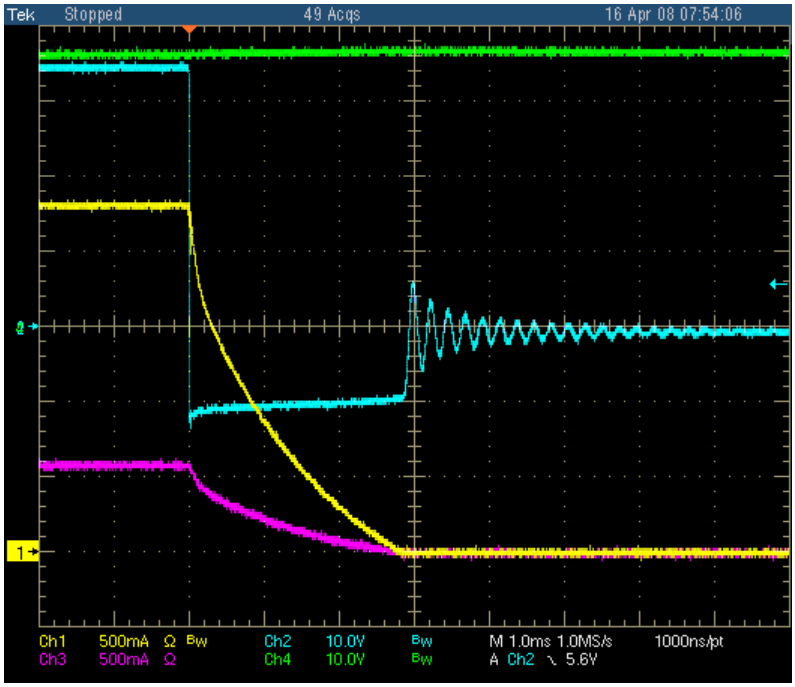
Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	35.7	1.250	35.3	0.566	36.5
15	35.7	1.183	35.3	0.556	38.1
30	35.7	1.185	35.3	0.555	38.6
60	35.7	1.186	35.3	0.555	38.8

Figure 18. Switching waveform (inductor, 36 V, 4 channels)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

Figure 19. Switching waveform (inductor, 36 V, 4 channels, turn-off detail)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

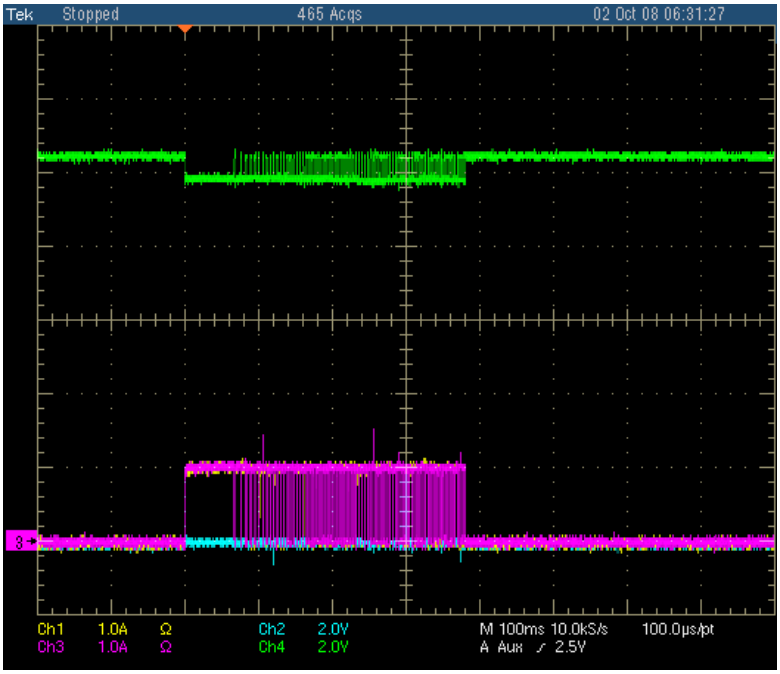
3 Short-circuit tests

3.1 Short-circuit, 10.5 V, 1 channel

Table 13. Test data (short-circuit, 10.5 V, 1 channel)
(V_{CC} = 10.5 V; load - 1 short-circuit; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	9.7	1.025	0.0	1.019	111.3
15	9.7	1.028	0.0	1.022	112.6
30	9.7	1.026	0.0	1.020	112.9
60	9.7	1.026	0.0	1.020	113.1

Figure 20. Switching waveform (short-circuit, 10.5 V, 1 channel)(1)



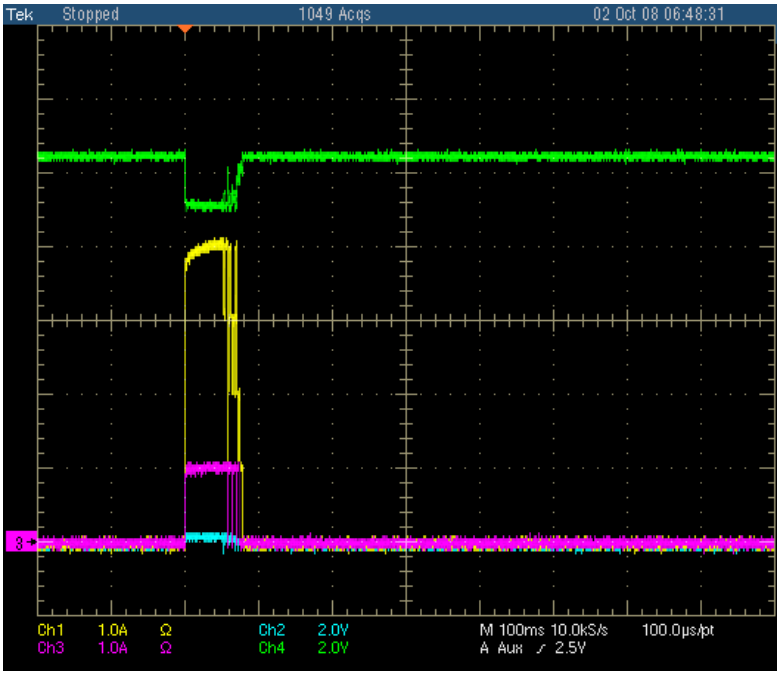
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

3.2 Short-circuit, 10.5 V, 4 channels

Table 14. Test data (short-circuit, 10.5 V, 4 channels)
(V_{CC} = 10.5V; load - 4 short-circuits; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	9.3	4.102	0.0	1.024	103.1
15	9.3	4.104	0.0	1.025	103.5
30	9.3	4.103	0.0	1.024	103.8
60	9.3	4.105	0.0	1.025	103.9

Figure 21. Switching waveform (short-circuit, 10.5 V, 4 channels)(1)



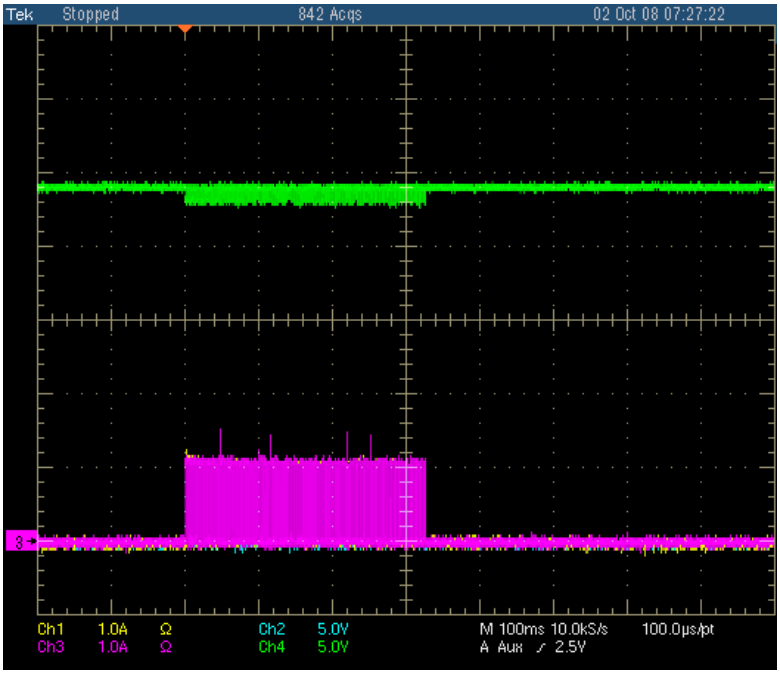
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

3.3 Short-circuit, 24 V, 1 channel

Table 15. Test data (short-circuit, 24 V, 1 channel)
(V_{CC} = 24 V; load - 1 short-circuit; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	23.3	0.964	0.0	0.958	109.1
15	23.3	0.965	0.0	0.959	109.4
30	23.3	0.965	0.0	0.959	109.6
60	23.3	0.967	0.0	0.961	109.7

Figure 22. Switching waveform (short-circuit, 24 V, 1 channel)(1)



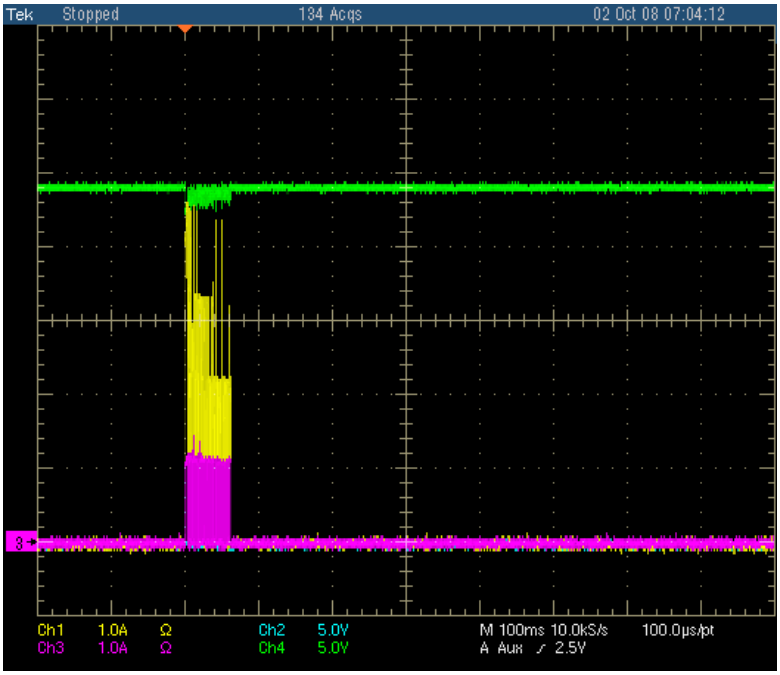
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

3.4 Short-circuit, 24 V, 4 channels

Table 16. Test data (short-circuit, 24 V, 4 channels)
(V_{CC} = 24 V; load - 4 short-circuits; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	23.3	2.512	0.0	0.627	102.3
15	23.3	2.511	0.0	0.626	102.4
30	23.3	2.513	0.0	0.627	102.5
60	23.3	2.514	0.0	0.627	102.5

Figure 23. Switching waveform (short-circuit, 24 V, 4 channels)(1)



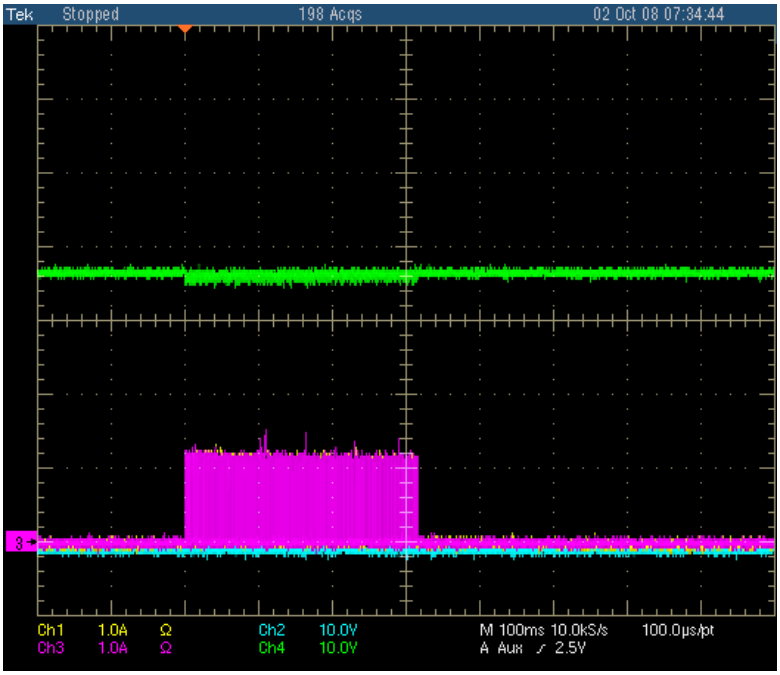
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

3.5 Short-circuit, 36 V, 1 channel

Table 17. Test data (short-circuit, 36 V, 1 channel) (V_{CC} = 36V; load - 1 short-circuit; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I^{ch} [A]	T_{case} [°C]
5	35.5	0.652	0.0	0.646	108.4
15	35.5	0.653	0.0	0.647	109.2
30	35.5	0.653	0.0	0.647	109.8
60	35.5	0.655	0.0	0.649	110.2

Figure 24. Switching waveform (short-circuit, 36 V, 1 channel)(1)



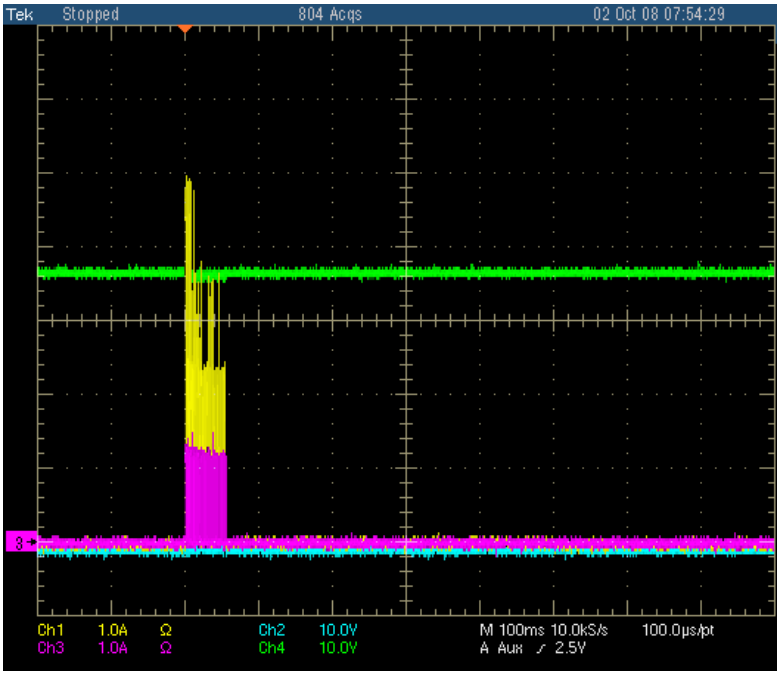
1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

3.6 Short-circuit, 36 V, 4 channels

Table 18. Test data (short-circuit, 36 V, 4 channels)
(V_{CC} = 36 V; load - 4 short-circuits; T = 25 °C)

Time [min]	U_{tot} [V]	I_{tot} [A]	U_{ch} [V]	I_{ch} [A]	T_{case} [°C]
5	35.5	1.720	0.0	0.429	101.0
15	35.5	1.722	0.0	0.429	101.1
30	35.5	1.724	0.0	0.430	101.2
60	35.5	1.725	0.0	0.430	101.2

Figure 25. Switching waveform (short-circuit, 36 V, 4 channels)(1)



1. CH1: supply current, CH2: channel voltage, CH3: channel current, CH4: supply voltage.

4 Conclusion

The device proved its full compliance and functionality under these more difficult conditions.

Note: In real applications and especially in the case of inductive loads requiring demagnetization it is not recommended to change the state of more than one output at a time.

5 Reference

1. VNI4140K datasheet.
2. AN2684 application note.

6 Revision history

Table 19. Document revision history

Date	Revision	Changes
09-Feb-2011	1	Initial release.

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